EFW Survey and High Rate Telemetry Mapping to AO-Sub-Goals

Summary: EFW total telemetry for combined high rate and survey modes is 6972 bps. This includes all internal burst playbacks. It assumes 5 days of high rate and 25 days of survey rate data in a 30 day month. It assumes no compression. It assumes a 9.5 hour orbit and a 5 rpm spin rate. It includes packetizing and it includes 10% margin. House keeping is a negligible contribution. Engineering modes associated with boom deployment and on orbit science evaluation during commissioning with be defined later but will not exceed this allocation. AO sub-goals are presented in the bottom rows of each table for those measurement capabilities which are enhanced.

Table 1a Survey Mode: Continuous Data

Measured Quantity	Ey, Ez spin plane	Ex axial	SC potential	E (ω)	B (ω:)	□□□□□ Survey Continous Rate (bps)
Data Type	time series	Time series	time series	spectra	spectra	
Components	2	1	6 probes	par/perp	par/perp	_
Freq. (min)	dc	dc	dc	1 Hz	1 Hz	_
Freq(max)	12 Hz	12 Hz	.5 Hz	2 kHz	2 kHz	_
Freq (res)	_	_	_	~6%	~6%	_
Freq. bins (log)	_	_	_	128	128	_
Range	±500 mV/m	00 mV/m	± 100V	100 dB	100 dB	_
Baseline Sensitivity	0.1 mV/m (spin fit)	3mV/m	10mV	10^{-14} $(V/m)^2Hz$	10^{-10} $(nT)^2/Hz$	
Resolution (LSB)	15μV/m	15μV/m	3 mV	--	--	_
Samples/s	32	32	1	0.167 1/2 spin	0.167 1/2 spin	_
Bits/Sample	16	16	16	8	8	_
Duty cycle	100%	100%	100%	100%	100%	_
Bits/s	1024	512	96	341	341	2314
Purpose	inject. front ULF waves convection small scale Alfven waves; emic;esic; LH	inject. front ULFwaves convection small scale waves emic;esic; LH	assess. operation of E-field instrument	E spectral pwr:	B spectral pwr	

Table 1b Survey Mode: Burst Quantities and Playback

	Proposed TM Modes (except 64 bps delta)		
	E/B/N waveform	Interferometric timing	total playback
Measured Quantities	3E, 3δB, δn	V_1,V_2 V_3, V_4 V_5, V_6	
Range	±500 mV/m, ± TBD 0.1 -100 cm^{-3}	10 mV to 100 V	
Frequency /velcoity range	100 Hz	300 (km/s)*	
Samples/s	200	3k	
duration of burst (s)	128	10	
number of bursts orbit	8	8	
total duration of burst/orbit (s)	1028	80	
total memory/orbit	23 Mbits	23 Mbits	
orbit averaged playback rate (bps)	672 (old 640)	672 (old 640)	1344 (old 1280)
Purpose	Provides wave E and B for very large amplitude small scale waves/structures	Interferometric timing to 300 km/s for waves below 100 Hz: phase velocity/k vector determination	

EFW Survey Telemetry
2314 survey continuous + 1344 survey burst =3658 survey total

80 s of interferometric mode 1028 s wave form E,B, density

Table 2a High Rate Continuous Data

	Proposed Mode							
	Ey, Ez spin plane	Ex axial	SC potential	E (ω)	B (ω)	Density (cold e-)	$\delta V_{ij}(\omega)$ single sensor	□□□□□ Data Rate High Rate Cont.
Data Type	time series	Time serie	time series	spectra	spectra	time series	spectra coherence phase lag	
Components	2	2	6 probes	par/perp	par/perp	1	2 probe pai spectra	_
Freq. (min)	dc	dc	dc	1 Hz	1 Hz	dc	1 Hz	_
Freq(max)	12 Hz	12 Hz	.5 Hz	2 kHz	2 kHz	12 Hz	2 kHz	_
Freq (res)	_	_	_	~6%	~6%	_	~6%	_
Freq. bins	_	_	_	128	128	_	128	_
Range	±500 mV/m	500 mV/m	± 100V	100 dB	100 dB	0.1-100 cm^{-3}	100 dB 360^0	_
Resolution (LSB)	15μV/m	15μV/m	3 mV	10^{-14} $(V/m)^2Hz$	10^{-10} $(nT)^2/Hz$	50%		_
Samples/s	32	32	1	0.167 (2/spin)	0.167 (2/spin)	32	0.167 (2 /spin)	_
Bits/Sample	16	16	16	8	8	16	8	_
Duty cycle	100%	100%	100%	100%	100%	100%	100%	_
Bits/s	1024	512	96	341	341	512	1026	3852
Purpose			assess. operation of E-field instrument			identify ave modes; asma density for n<100 cm_3.	phase velocity; 2D k-vector coherence of waves	
AO Objective			diagnostic				1.1a, 1.1.e, , 3e, 4.1 4.2, 5c, 5e, 6c,7d	

Table 2b High Rate Burst Quantities and Playback (rates, duration adjustable)

	E/B/δn waveform				Med Resolution Interferometric timing	High Resolution Interferometric timing	Total TM (bps)
Measured Quantities	3E, 3δB,δn				V_1,V_2 V_3, V_4 V_5, V_6	V_1,V_2 V_3, V_4 V_5, V_6 , 3δB	
Range	±500 mV/m, ±10 nT 0.1 -100 cm^{-3}				10 mV to 100 V	10 mV to 100 V	
Freq/ Vel. Range	100 Hz				300 (km/s)	1000 (km/s)	
Samples/s (typical)	300				6k	20k	
Region/ Structure	Inject Event	Radial Interval.	Turb. ULF Regions	Ring Cur.	Imbedded in Wave form Bursts of Col.1	Imbedded in Wave form Bursts of Column 1	
Duration burst (s)	600	60	400	400	10	10	
#Burst/orb	5	16	2	2	12	12	
Tot Dur. /Orb	6168s				240s	120 s	
Orb. Ave. Playback	6048 bps				2016 bps	6720 bps	14784
Collection strategy	1) ~0.5 Re radial intervals over orbit between 2-6 Re 2) Most intense intervals of turbulence/acceleration associated with substorm injections/boundaries turbulent ULF/MHD wave fields				1) 0.5 Re radial intervals over orbit between 2-6 Re 2) Most intense intervals of turbulence/acceleration	1) 0.5 Re radial intervals over orbit between 2-6 Re 2) During several intense intervals of turbulent/acceleration	
Purpose	3D E-field and 3 D B-field plus Density fluctuations. Target waves: EMIC.ESIC, LH, KAW, Oblique Magnetosonic, Non-linear Structures. Detailed analysis of wave structure. Stochastic vs Coherent Accel/Scattering				Interferometric timing for 2-D phase velocity up to 300 km/s; (adjustable) 2- D k vector, for ES/ EM waves/structures below 100 Hz Also provides E-field density (can include δB)	Phase velocity up to 1000 km/s (adjust.); k vector for ES/EMwaves/structures; Provides E-field; Density fluctuations: diagnostic of mode structure and cause of turbulent prop. of waves & decoherence	
AO objective	1.1a, 1.1.e, 2a, 3c, 3e, 4.1 4.2,4.5 5c, 5e, 6c,7d				1.1a, 1.1.e, 2a, 3c, 3e, 4.1 4.2,4.5 5c, 5e, 6c,7d	1.1a, 1.1.e, 2a, 3c, 3e, 4.1 4.2, 4.5 5c, 5e, 6c,7d	

Note These burst modes are typical examples: the format, number of bursts, durations are adjustable with in the constraint of a fixed TM allocation.

High Rate
TM =3852 (continuous) + 14,784 (internal burst) =18,636 bps (during major acceleration events typically lasting five days once per month)

Cumulative Data Rate Averaged over a Month of Survey and High Rate Data Plus Overhead and Margin

Assumes 10 hour orbit 5 RPM 3% packetizing overhead, 5 days of high rate date and 25 days of survey out of 30 day month. No compression. house keeping negligible. and deployment modes within margin

TM Mode	Orbit Averaged Playback (bps)	Duty Cycle of Mode	Duty Cycle Normalized Playback Rate (bps or %)
Survey	3658	25 days/30 days	3048
High Rate	18636	5 days/30 days	3106
Packetizing overhead (3%)			
Margin (10%)			10%
total tm averaged over month (bps)			6972

For a typical month our average tm allocation for all modes is 6972 bps.